National Certificate of Educational Achievement
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Exemplar for Internal Assessment Resource
Physics Level 1

Resource title: Spring Experiment

This exemplar supports assessment against:

Achievement Standard 90935

Carry Out a Practical Investigation, With Direction, That Leads to a Linear Mathematical Relationship

Grade boundary specific exemplar

The exemplar has been developed from student material specific to an A or B assessment resource.

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To support internal assessment from 2011

	Grade Boundary: High Merit / Low Excellence
	The student has made too many errors which have to be taken into account when deciding the final grade. The discussion is well above the minimum acceptable level and the student has demonstrated very clearly that the experimental process is well understood. If, in his class experiments, this student has demonstrated he does not usually make such mistakes, there is sufficient evidence for an excellence grade to be appropriate.
1.	The calculation of the force values has not been carried out correctly as the mass has been used in grams rather than kilograms.
	Errors in this processing may account for the fact that the measurements are not as accurate as they should be.
2.	When the extensions have been averaged a number of the averages have been incorrectly calculated.
3.	Two of the points have been plotted incorrectly (but eight are correctly plotted).
4.	When determining the “run” in the gradient calculation the force scale has been read incorrectly and so the value of the gradient is not correct. However, the method used when calculating the gradient is very good.

Title: Spring Experiment

Aim: To find the mathematical relationship between the extension of a spring and the force that causes it to stretch.

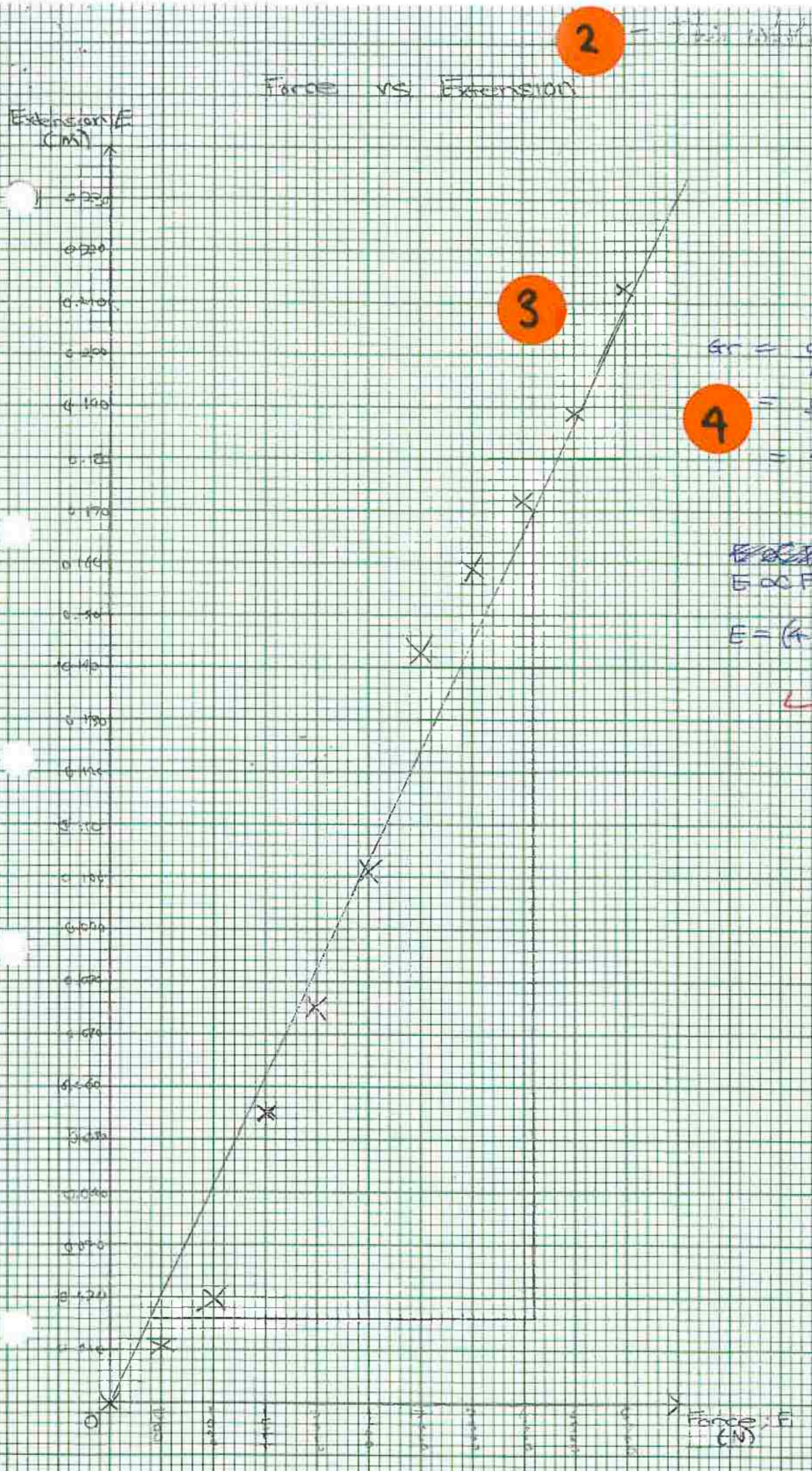
Equipments: · set of weights
· Stand and clamp
· Spring
· 1m ruler (zero error = +0.005m)

Hypothesis: I think the extension of the spring and the force that causes it, will have a directly proportional relationship.

Method:
1) Stand the stand & clamp on a flat surface.
2) "Hang" the spring to the clamp.
3) Vertically lay the 1m ruler perpendicular to the ground. (can be done using a square object)
4) Using a 50g weight, attach to the string and record the extension.
5) Repeat step ④ 3 times to obtain a more accurate result by averaging
6) Adding weights at regular intervals (ie 50g each time), repeat step ⑤.
7) Record the results.

Spring is 0.307m above. ⇒ 0.302m (zero error accounted)

Force (N)	Trial 1 (m)	Trial 2 (m)	Trial 3 (cm)	Final Result (m)	
0N	0	0	0	0	⇒ 0 m
500 N	0.011	0.010	0.013	0.011	⇒ 0.011
1000 N	0.035	0.077	0.040	0.025	⇒ 0.020
1500 N	0.059	0.061	0.060	0.060	⇒ 0.055
2000 N	0.080	0.076	0.083	0.080	⇒ 0.075
2500 N	0.107	0.103	0.108	0.106	⇒ 0.101
3000 N	0.171	0.173	0.170	0.171	⇒ 0.165
3500 N	0.175	0.170	0.172	0.172	⇒ 0.167
4000 N	0.177	0.175	0.179	0.177	⇒ 0.172
4500 N	0.192	0.195	0.194	0.194	⇒ 0.189
5000 N	0.219	0.220	0.215	0.218	⇒ 0.213



$$Gr = \frac{0.170 - 0.016}{4100 - 400}$$

4 $$= \frac{0.154}{3610}$$

$$= 4.27 \times 10^{-5}$$

~~E ∝ F~~ ~~k = E/F~~

$E \propto F$

$E = (4.27 \times 10^{-5}) F$

	Grade Boundary: High Merit
	If there had been a reasonable attempt to explain the intercept the discussion would have had enough good points for this to be an excellence script. However, the failure to recognise the intercept as being a problem is a significant issue and makes the report a High Merit, not Excellence.
5.	The spring extensions have been calculated from the raw spring lengths before the results were entered into the table. All raw measurements should be recorded so that the extension calculations can be checked if necessary.
6.	The relationship equation has the correct form except that it indicates that there is no intercept. The graph clearly shows otherwise, and the discussion does not address this discrepancy.
7.	A controlled variable was stated in the method (“The spring will be kept the same”), but the necessity for its control is not explained in the discussion.
	The technique that was used to overcome the difficulty described is really no more than correct experimental practice.

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Mass (g)	Force applied (N)	Extension of spring (mm)			
		T1	T2	T3	AVE
50	0.5	~~0.00~~2	02	01	02
100	1.0	~~0.0~~14	15	15	15
150	1.5	~~0.0~~29	31	31	30
200	2.0	~~0.0~~44	46	47	46
250	2.5	60	61	66	60
300	3.0	74	76	76	75
350	3.5	89	89	91	90
400	4.0	104	106	107	106
450	4.5	124	120	123	122
500	5.0	135	136	139	137
00	00	00	00	00	00

Spring Length: T1 = 73mm
T2 = 73mm
T3 = 73mm

Conclusion: The aim of this experiment was to find the mathematical relationship between the extension of a spring and the force that causes it to stretch. From the data gathered and the graph plotted, the extension of the spring and the force that caused it to stretch are directionally proportional to each other.

Gradient: ~~$\frac{137-60}{500-250}$ = 0.31 mm/g~~ $\frac{137-60}{5-2.5}$ = ~~30.8 N/m~~
= 30.8 mm/N
= 0.0308 m/N

Equation: $y = mx + c$

~~$x = 30.8F + 0$~~

6 $x = 0.0308F + 0$

During the experiment, I found it a bit challenging to get an accurate measurement for the extension of the spring because it would move due to the 50g masses attached to it, or by a simple touch of the ruler. I knew that if I touched the spring with my hand and held it steady, I may distort the spring by applying a downward or upward ~~push~~ force, thereby making the results less accurate. In the end, I waited until the spring was motion-less to take the measurement.

The results gathered are valid and reliable because the experiment was ~~repeated~~ carried out 3 times to ensure an accurate average was obtained, the same equipment was used for all three trials, it was done in the same classroom within one hour. Also while reading the measurements ~~a~~ I was at eye level with what I was measuring, thereby decreasing and almos eliminating parallax error and furthermore increasing the accuracy of my results.

By choosing a range of masses to apply to the spring (0g, 50g, 100g, 150g, 200g, 250g, 300g, 350g, 400g, 450g, 500g), I was able to get a more accurate illustration, with the help of the graph, on the relationship between the force applied to the spring and its extension.

Next time, I would repeat the experiment several more times, just to increase the accuracy of the results gathered and to further illustrate the relationship between the force applied to a spring and its extension.

	Grade Boundary: Low Merit
	Normally the incorrect form of the equation would mean the student could not be awarded Merit. However in this case, the word form of the equation is just enough evidence for it to be assumed the student knows what y and x represents and Merit can be awarded.
8.	The gradient working has not been shown but as its value is correct it can be assumed correct method and working has been used, however, the relationship equation has been given in terms of x and y rather than length and weight.
9.	The relationship equation has been expressed in words.

Interpretation of Data:

8 The data produced a linear graph, $y = 4x + 4$. As the weight is increased the length of the spring increases.

Conclusion:

The mathematical relationship between the weight force
9 and extension of the string is for every 1N of force, the spring extends 4 cm.

Evaluation of the Method and Data and / or Science ideas

	Grade Boundary: High Achieved
	The problem with the form of the equation is significant, and this by itself is enough to make it not appropriate for Merit to be awarded. If the equation had been written in the correct form, the only aspect of the report that would not have been above the Merit minimum level would have been the incorrect gradient calculation. As this is an experimental standard, the mathematical mistake in the gradient could be overlooked and Merit awarded.
10.	The method for calculating the gradient of the graph is correct but when writing down the final calculated value, the power of 10 has been omitted.
11.	The form of the equation shows only limited understanding of how to construct an equation from a graph line.

10 Gradient = $\frac{0.17 - 0.01}{490 - 30} = \frac{0.16}{460} = 3.48$ m/g

Extension is directly proportional to ~~force~~ mass
$E \propto m$

11 Equation = 3.48x

Conclusion - as the mass increases the extension of the spring increases too.

Discussion -
Throughout the experiment there were things that I did to make ~~the~~ it more accurate like avoiding parallax error by reading it at eye level. ~~We~~ I also avoided zero error by taking away ~~the~~ from the measurements. I also completed the test three times and then calculated the average ~~by~~ to make the test more accurate. ~~To improve the inves~~ Things that could of been done better were waiting until the spring stopped bouncing/swining so that the reading could be more accurate. Another could be taken more time in reading the measurement instead of rushing through it.

	Grade Boundary: Low Achieved
	An incorrect conclusion statement would usually mean the student cannot be given achieved. However, the information gathering and analysis is well above the minimum achievement standard and it is reasonable to assume “number” of weights implies mass of weights, achievement can be awarded.
12.	The method does not make it clear that the student understands what is meant by the dependent and independent variables. However, the results table shows that although the terminology might not be known, the practical application is understood.
13.	The conclusion statement is not clear in that it refers to the number of weights rather than the mass of the weights. This is a significant issue because a correct conclusion is the fundamental requirement of the experiment.

10/03/10

Physics Practise test

Chart of data collected

Mass	1) Length of Spring	2)	3)	Average
100 g	309 mm	309 mm	309 mm	309 mm
200 g	354 mm	354 mm	354 mm	354 mm
300 g	401 mm	401 mm	401 mm	401 mm
400 g	444 mm	444 mm	444 mm	444 mm
500 g	494 mm	496 mm	494 mm	496 mm

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Method

1) I first removed all weights untill it was 100g, this is the indepedant variable.
2) I then hooked the spring onto the stand, the spring is the dependant variable.
3) I then hooked the weights onto the spring and let the spring stretch on it's own.
4) I then ~~placed the~~ aligned the start of the ruler (0mm) with the very start of the spring, I measured all the way down to the end of the spring, the ruler was my controlled variable.
5) ~~After measuring~~ I then checked 3 times how long the spring had stretched to ensure my results were reliable.
6) Next I added another 100g to the weights and ~~folled~~ followed the same steps, I followed the same steps every time 100g was added.

Aim

- To find the mathematical relationship between the extension of a spring and the force that causes it to stretch.

Variables

Dependant - Spring
Independent - Weights
Controlled - Ruler

Justifications

- Finding out ~~the averages of the length of the~~ the length of the stretched spring averages increase the accuracy of finding the correct length.
- It was necessary to control where the ruler was placed along the spring to ensure I got a correct measurement.

Graph showing how far the spring stretched at certain at ~~[illegible]~~ different weights

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~~The line of best fit suggests that~~
- The number of weights are directly proportional to the length of the spring.
- Gradient of the graph $\frac{475}{470} = 1.01$

	Grade Boundary: High Not Achieved
	The issues with the description of the relationship are sufficiently significant for it to be inappropriate to award Achievement. If the relationship had been described well, the issue with the method could have been overlooked.
14.	The method is marginal but just acceptable for achievement provided the rest of the report is above the minimum Achievement grade.
15.	The gradient calculation shows some understanding of how to calculate a gradient. The statement of the equation in words shows some understanding of the type of relationship.

Aim: To find the mathematical relationship between the extention of a Spring and the force that causes it to stretch.

Method:

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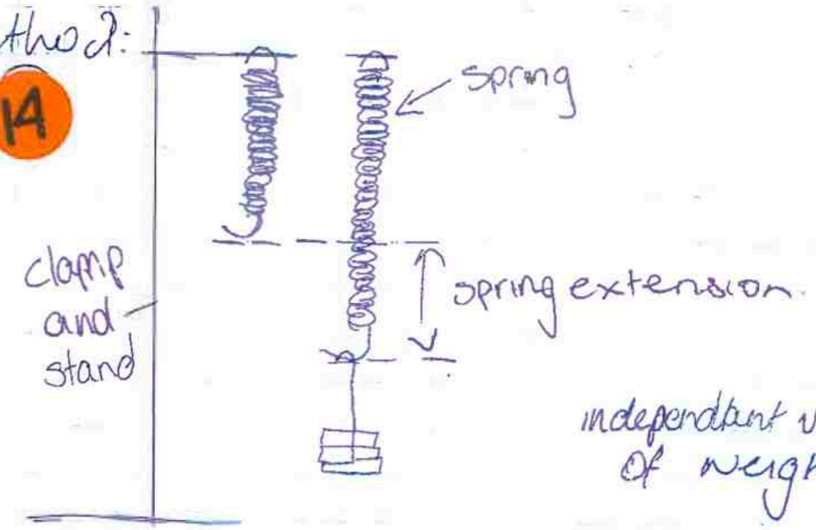

independant variable: The amou[nt] Of weight on the spring

Dependant variable: The lengt[h] the spring extends.

Controlled: the spring used Measure when still. measure with same rule.

Spring extension (cm)

weight(g)	Trial 1	trial 2	trial 3	averages
0	2.2	2.2	2.2	2.2
50g	3.8	3.4	3.9	3.83
100g	6.0	6	6.1	6.03
150g	8.1	8.2	8.3	8.2
200g	10.2	10.4	10.3	10.3
250g	12.5	~~10~~ 12.5	12.6	12.53

analysis of data

The line of best fit rises to 12.2cm over the 250g. This means the gradient is $\frac{12.2}{250} = \frac{20}{?}$ 0.05. With that gradient we can see that ~~with~~ if we add 20g the spring will extend 1 cm.

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